Environmental Institute of Houston

University of Houston Clear Lake

Spatial Patterns in Texas Lotic Fish Communities

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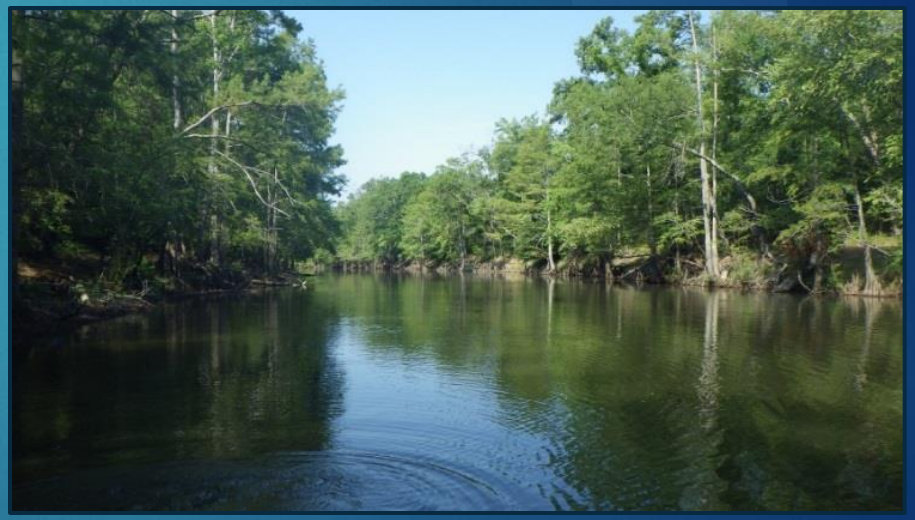
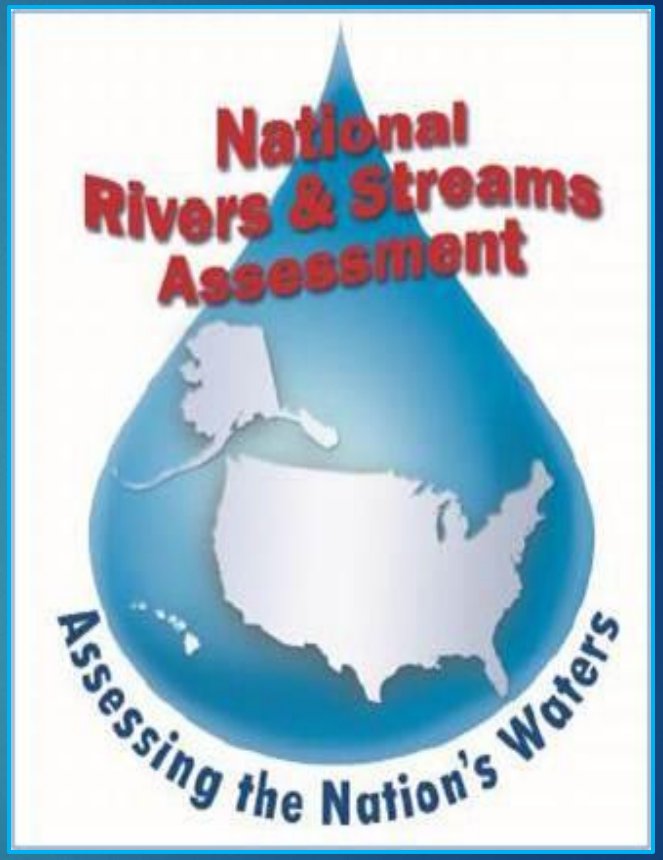
Factors Impacting Rivers and Streams

- Industrialization, urbanization, and agriculture
  - Reservoir construction
  - Increased freshwater diversions
  - Additional wastewater loads
  - Pollution
  - Dredging
  - Saline intrusions
  - Proliferation of exotic species



The National Rivers and Streams Assessment

- First implemented by the EPA in 2008-2009
  - 55% of the nation's rivers and streams did not support healthy populations of aquatic life[1]
- Second NRSA project completed 2013-2014
  - The Environmental Institute of Houston (EIH) conducted these surveys across Texas in collaboration with TCEQ



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TCEQ

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

(1) EPA 2013

Expectations

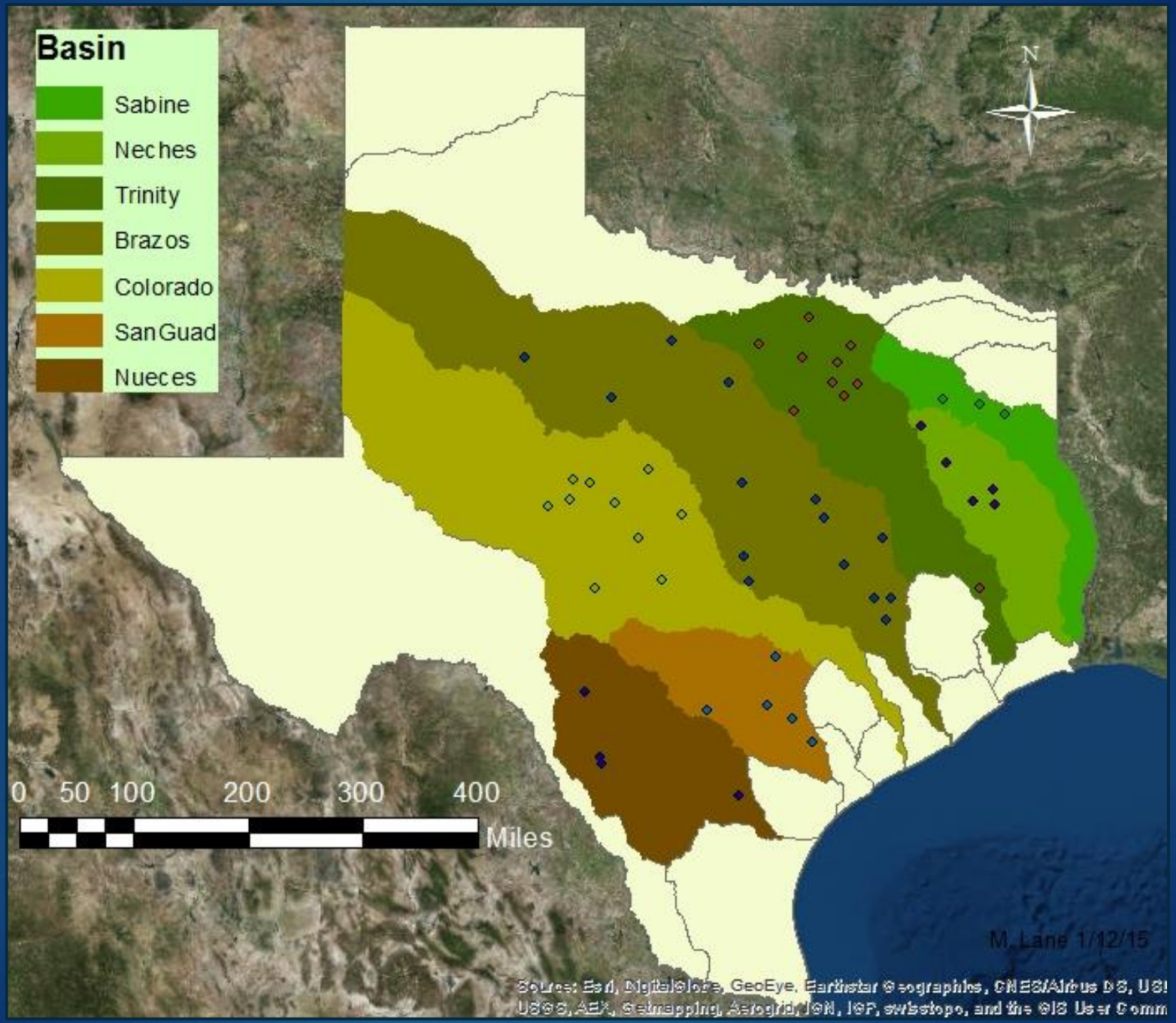
- Fish Communities
  - Vary considerably across Texas
  - Shift towards greater evenness in statewide diversity[1]
- Longitudinal Gradient
  - Exists along western Gulf slope drainages[2]

- Land use/Land cover
  - Land disturbances (i.e. development and agriculture) negatively affect fish communities[3]

(1) Anderson et al. 1995, (2) Conner & Suttkus 1986, (3) Allan 2004

Objectives

- Describe fish community metrics in Texas watersheds and review historic trends
- Evaluate potential longitudinal gradients observed across sample sites
- Assess the relationship between fish community metrics and land use/land cover


Basin
Sabine
Neches
Trinity
Brazos
Colorado
SanGuad
Nueces
N
0 50 100 200 300 400
Miles
M. Lane 1/12/15

Site Selection

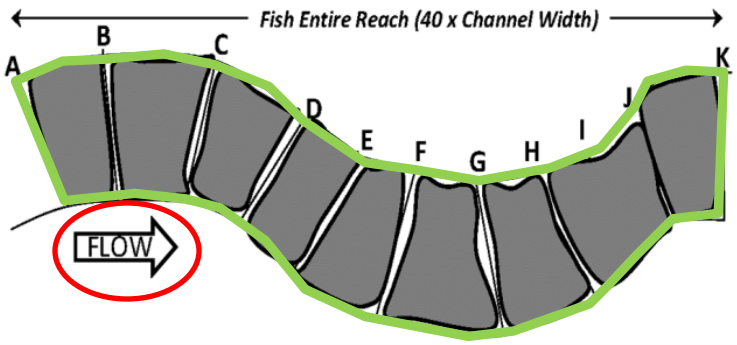
- Sampling frame derived from National Hydrography Dataset (NHD); randomly selected sites classified as "boatable" or "wadeable"
- Each site was located with GPS coordinates determined by the EPA

Sampling Methods

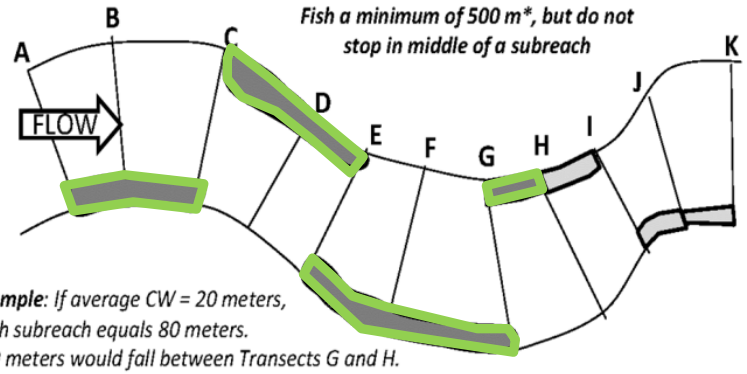
- Fish Community
- Benthic macroinvertebrates and periphyton
- Streamflow
- Water quality
- Physical Habitat
  - Instream
  - Riparian
  - Slope & Bearing

Boatable

Small Non-wadeable River: Channel Width < 12.5 m

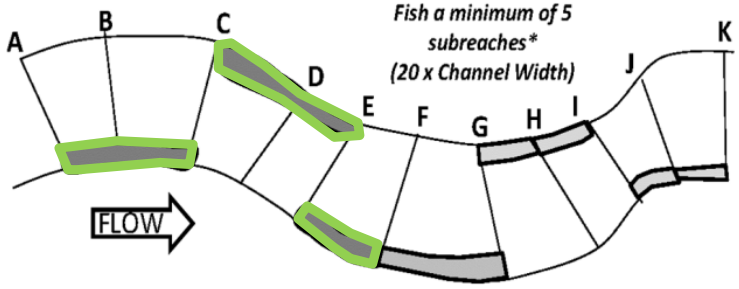


Medium Non-wadeable River: Channel Width 12.5 m to 25 m



***Example**: If average CW = 20 meters,*
each subreach equals 80 meters.
500 meters would fall between Transects G and H.
Initial fishing reach would stop at Transect H and equal 560 meters.

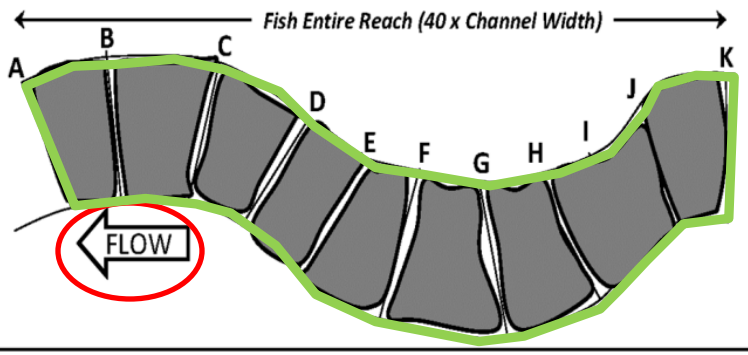
Large Non-wadeable River: Channel Width > 25 m



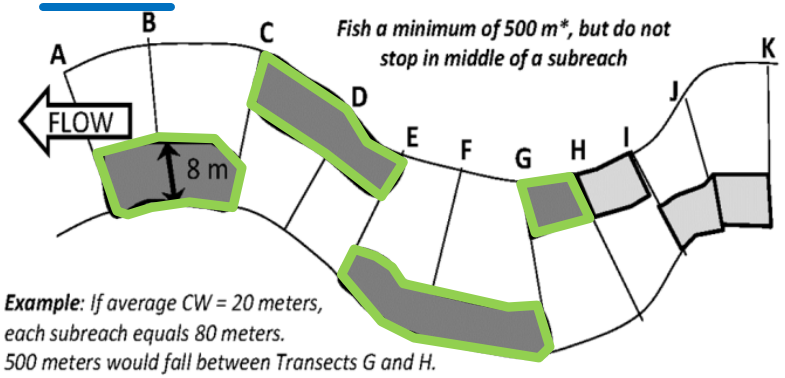
*At medium & large rivers, if < 500 individuals have been collected after minimum sampling reach, continue fishing to next transect (alternating banks) until 500 individuals are collected or Transect K is reached, (10 subreaches fished)

Wadeable

Small Wadeable Stream: Channel Width < 12.5 m



Medium Wadeable Stream: Channel Width 12.5 m to 25 m



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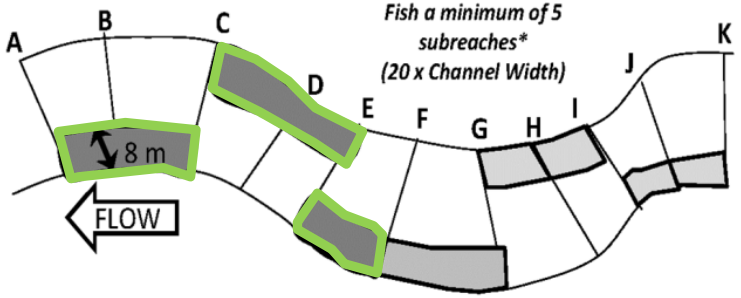


*At medium & large streams, if < 500 individuals have been collected after minimum sampling reach, continue fishing to next transect (alternating banks) until 500 individuals are collected or Transect K is reached, (10 subreaches fished)

Image Source: EPA 2013

Fish Community Metrics

- Species richness and Shannon's diversity were computed for each sample site
- Indexes of biotic integrity (IBIs) adjusted for each ecoregion were calculated for each site[1]

(1) Linam et al. 2002

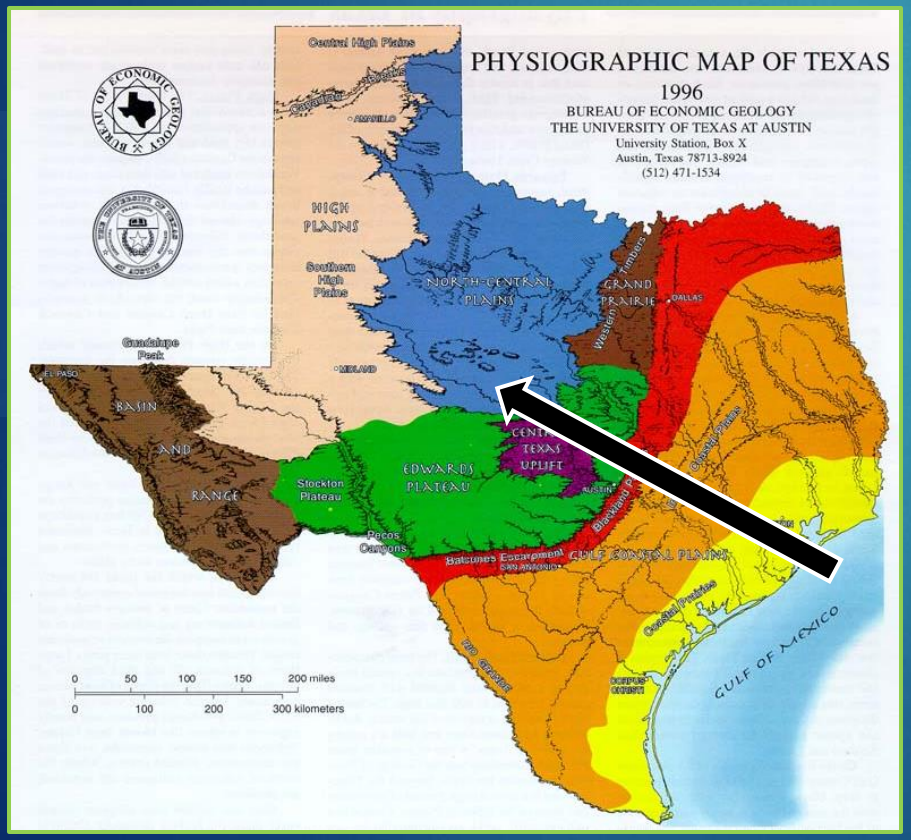
Historic Trends

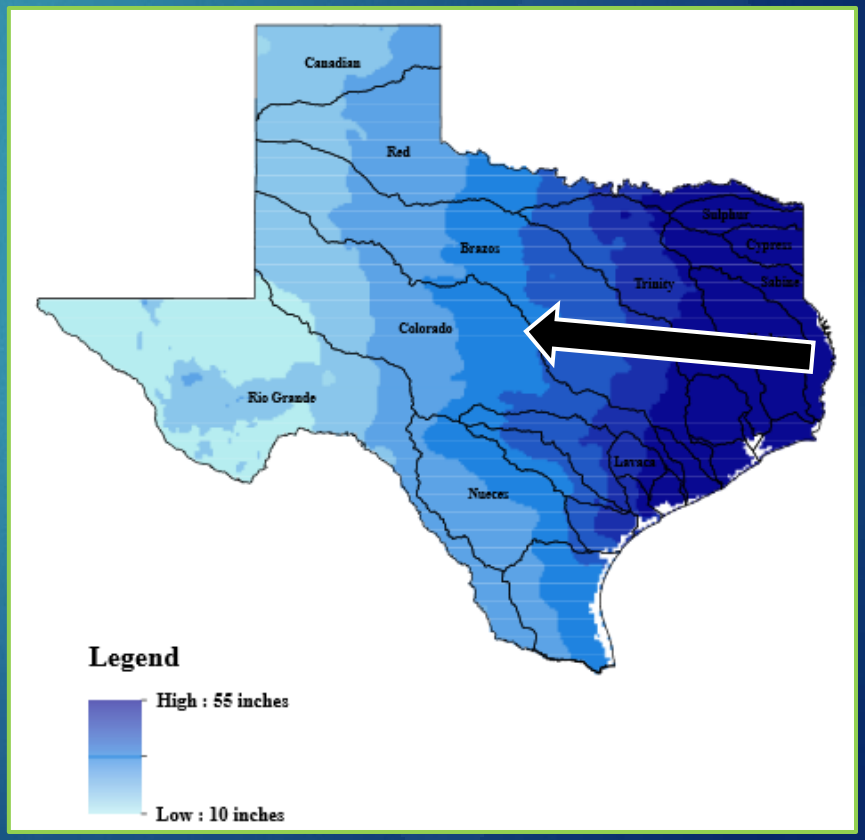
- Relative proportions of families were computed for each drainage and compared:
  - To each other with respect to our data
  - To (approximated) historical proportions from 1953 and 1986[1]

(1) Anderson et al. 1995

Longitudinal Gradients

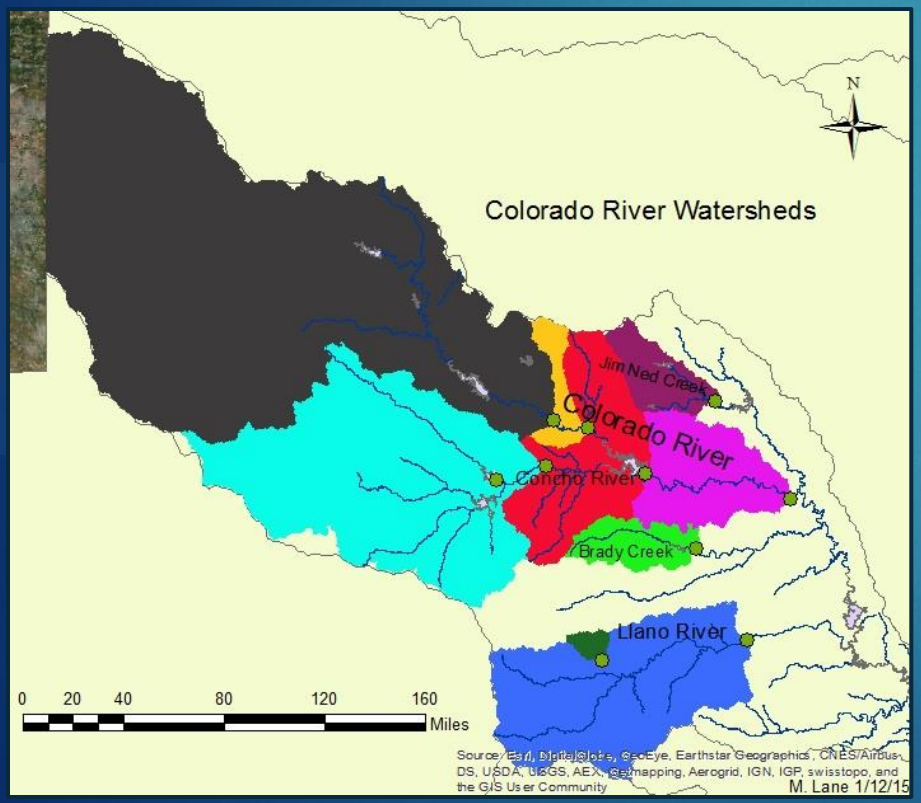
- Conducted regressions for species richness and diversity against longitude
  - Analyzed all sites as a whole
  - Analyzed sites separated into drainages

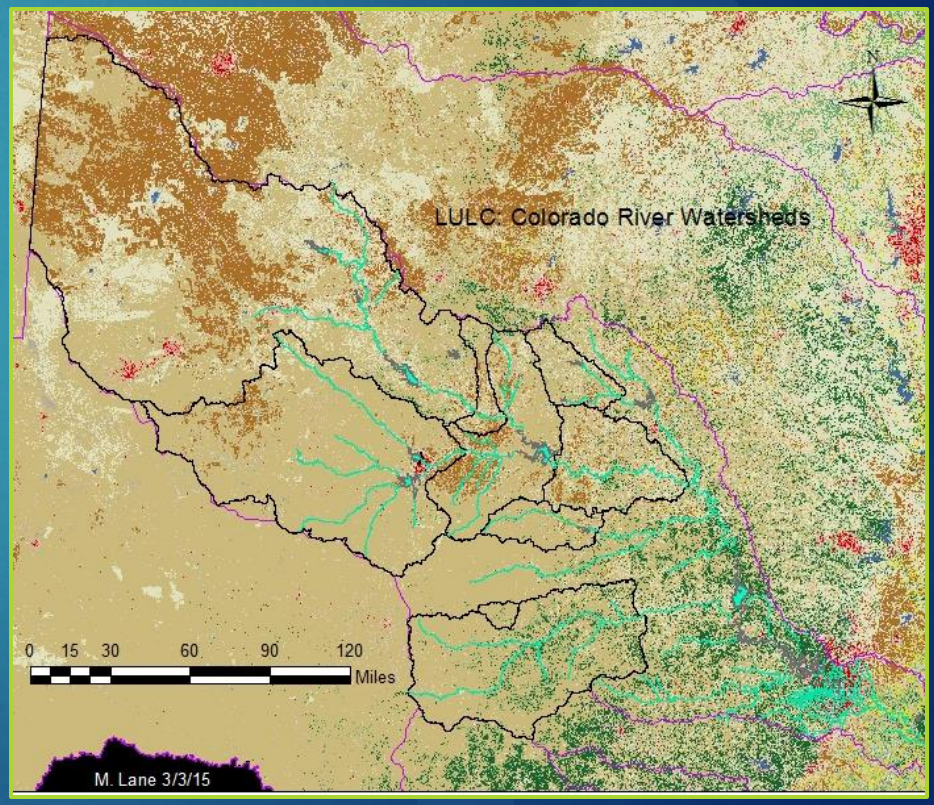




GIS Analysis

- Watersheds relative to each sample site were mapped using ArcGIS software
- Upstream drainage area as well as land use/land cover (LULC) were examined for each site's watershed





Comparing fish communities to LULC

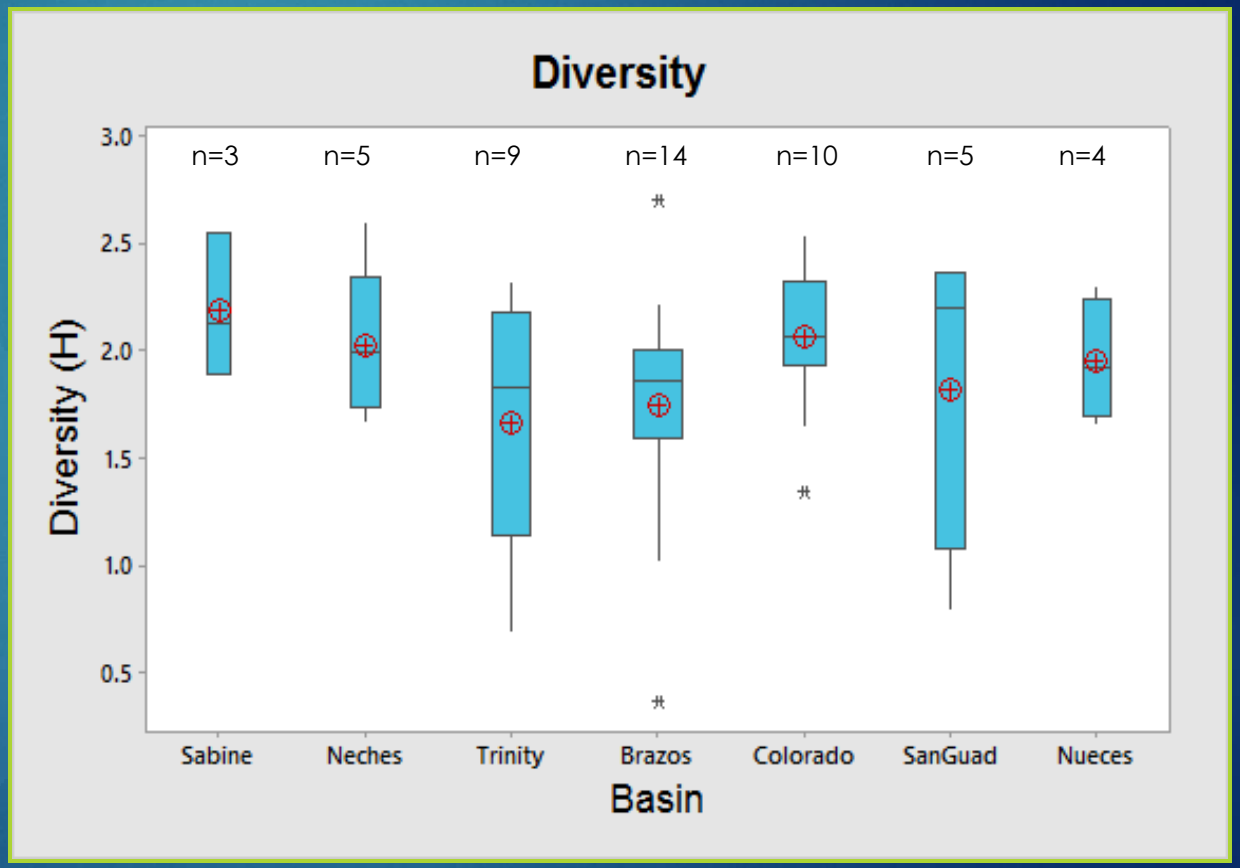
- Principal Component Analysis (PCA) conducted to ordinate sites and basins relative to LULC

- Percent disturbed land was regressed against fish community metrics
  - Species richness
  - Shannon's diversity
  - Index of Biotic Integrity (%)

Community Composition

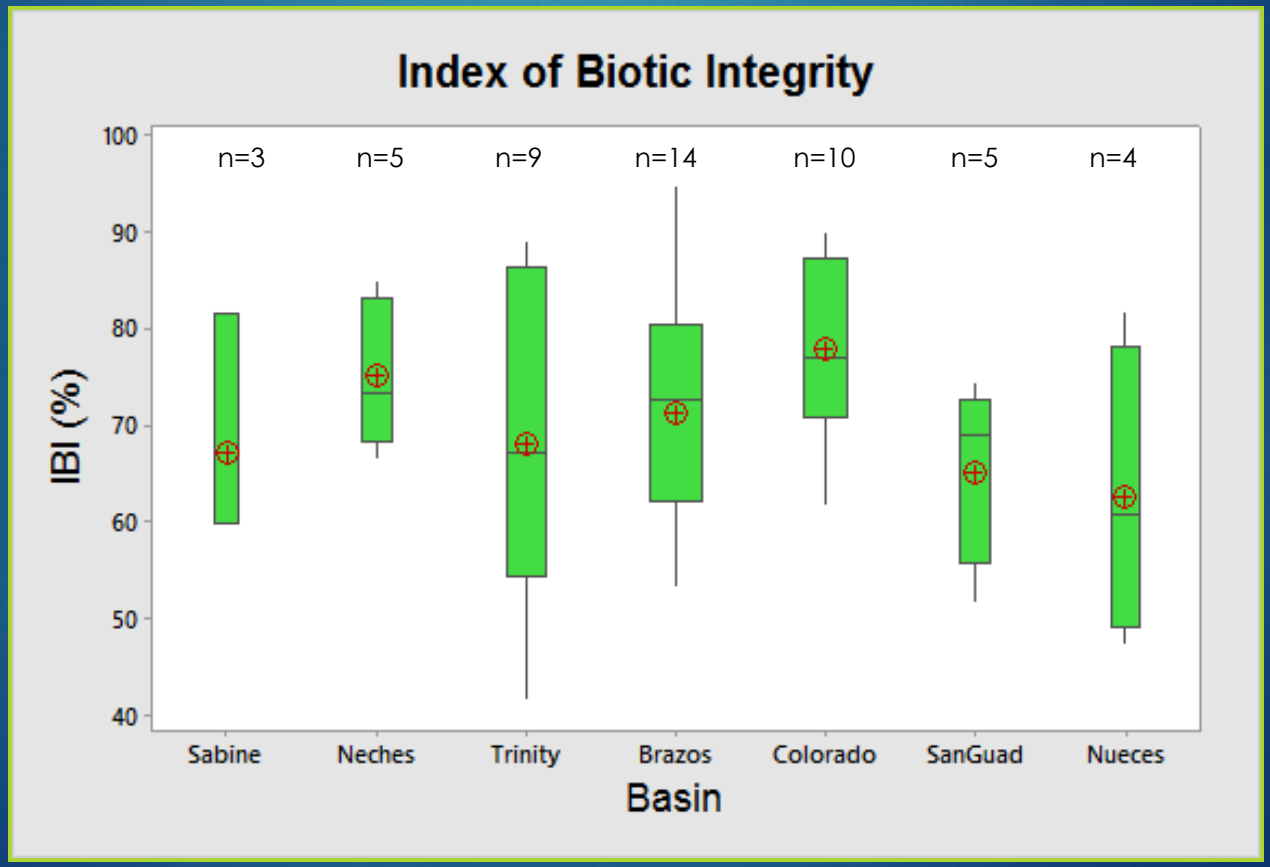
- In 51 sampling events:
  - 28,442 individuals
  - 20 families
  - 45 genera
  - 91 species

- Richness ranged from 2 to 25
- Diversity ranged from 0.37 to 2.70

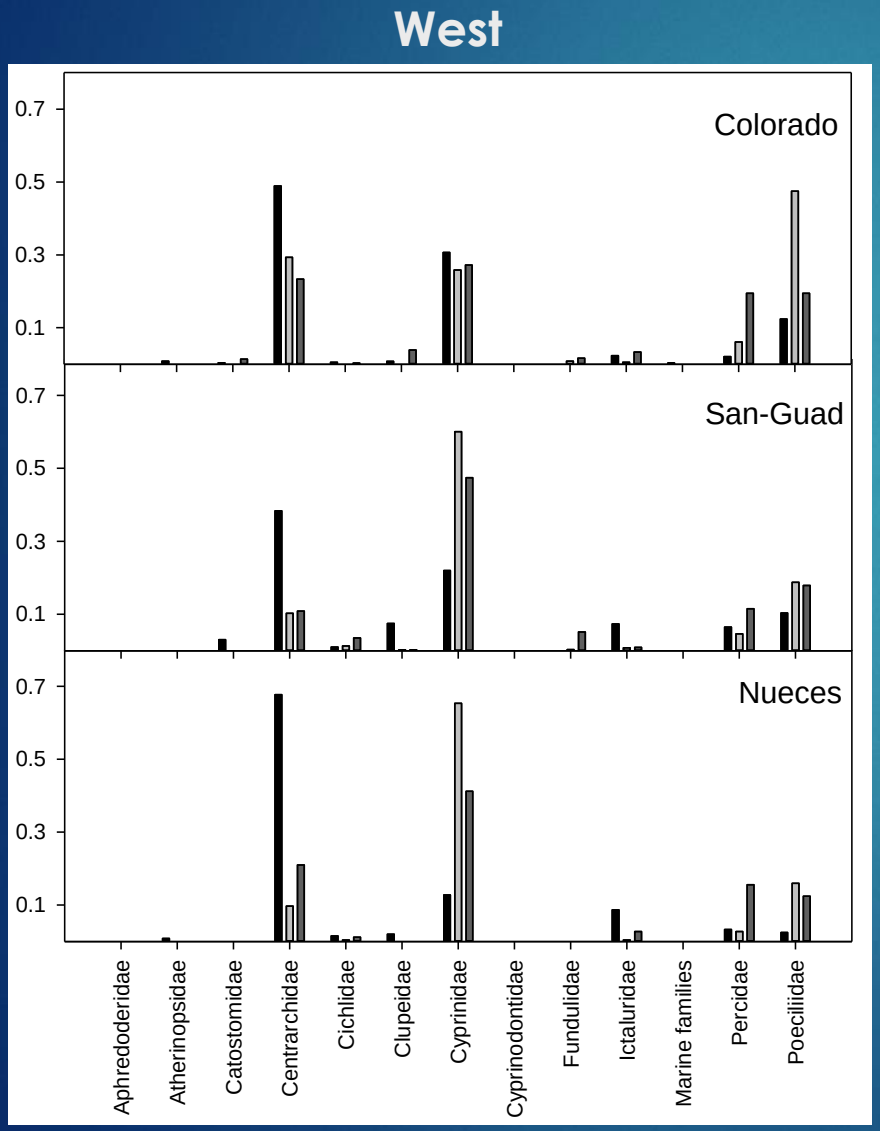


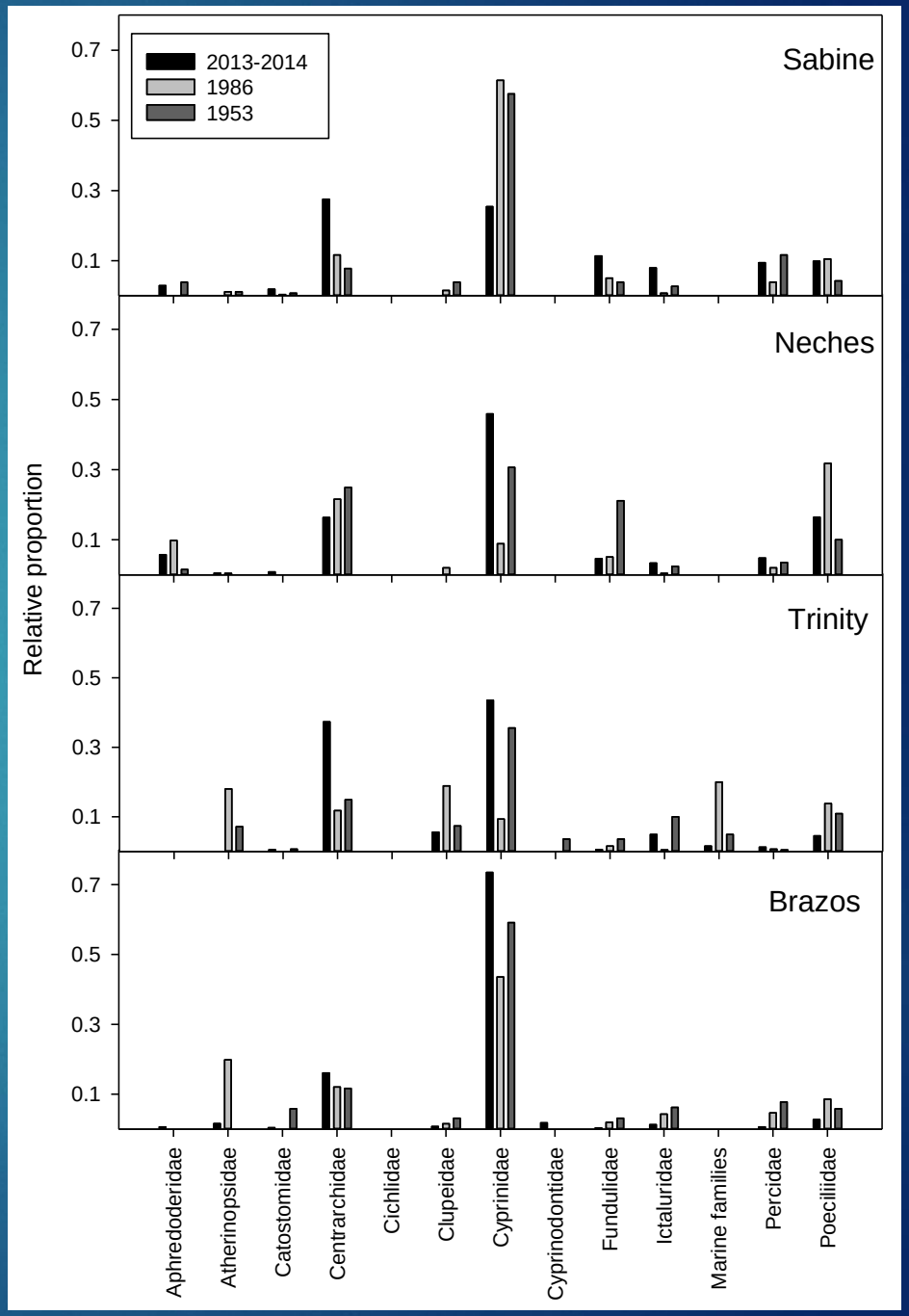
Index of Biotic Integrity

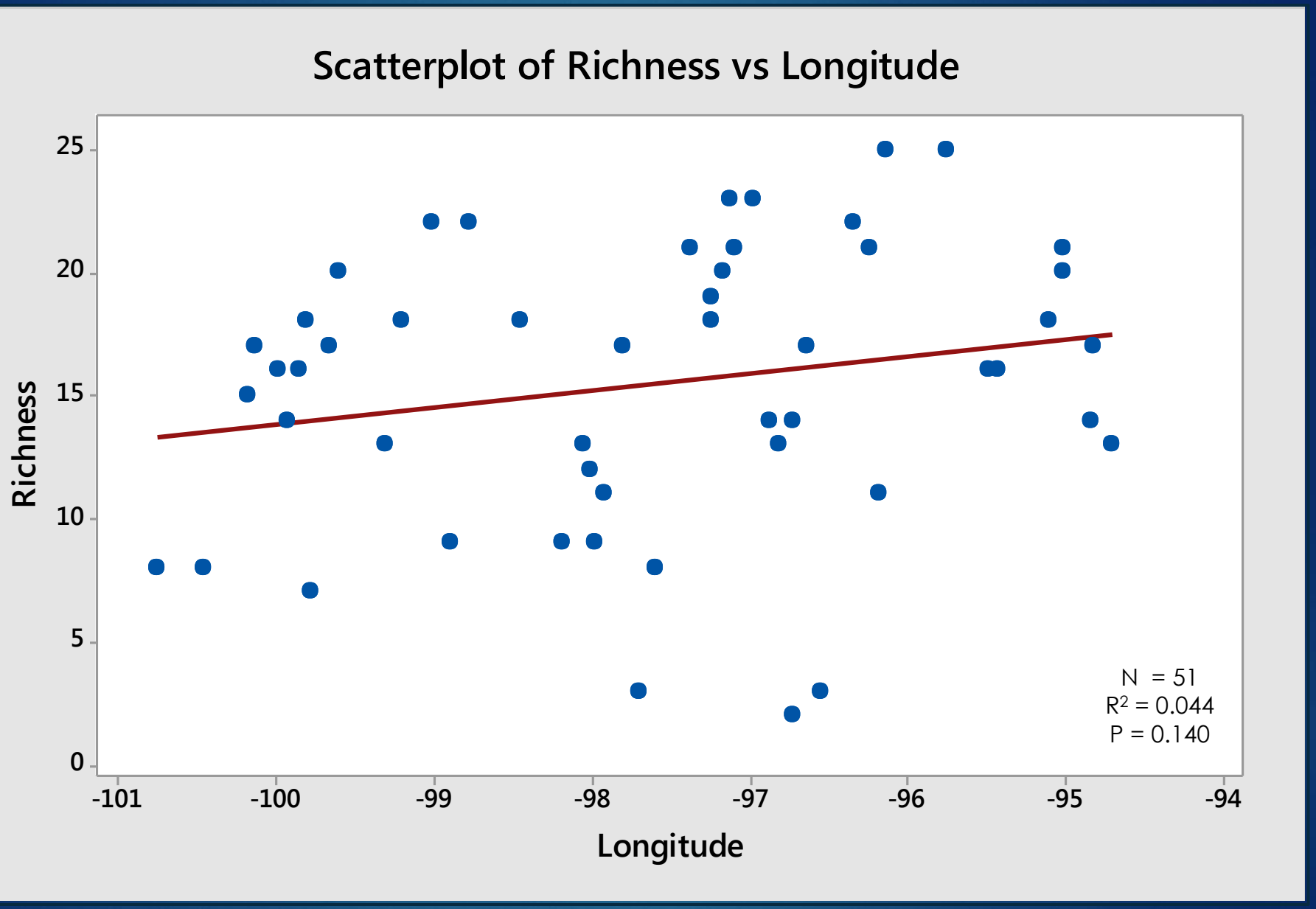
	Sabine	Neches	Trinity	Brazos	Colorado	SanGuad	Nueces
Limited			4	2	1		
Intermediate	2	1	1	6	4	4	2
High	1	4	2	4	2	1	1
Exceptional			2	2	3		1

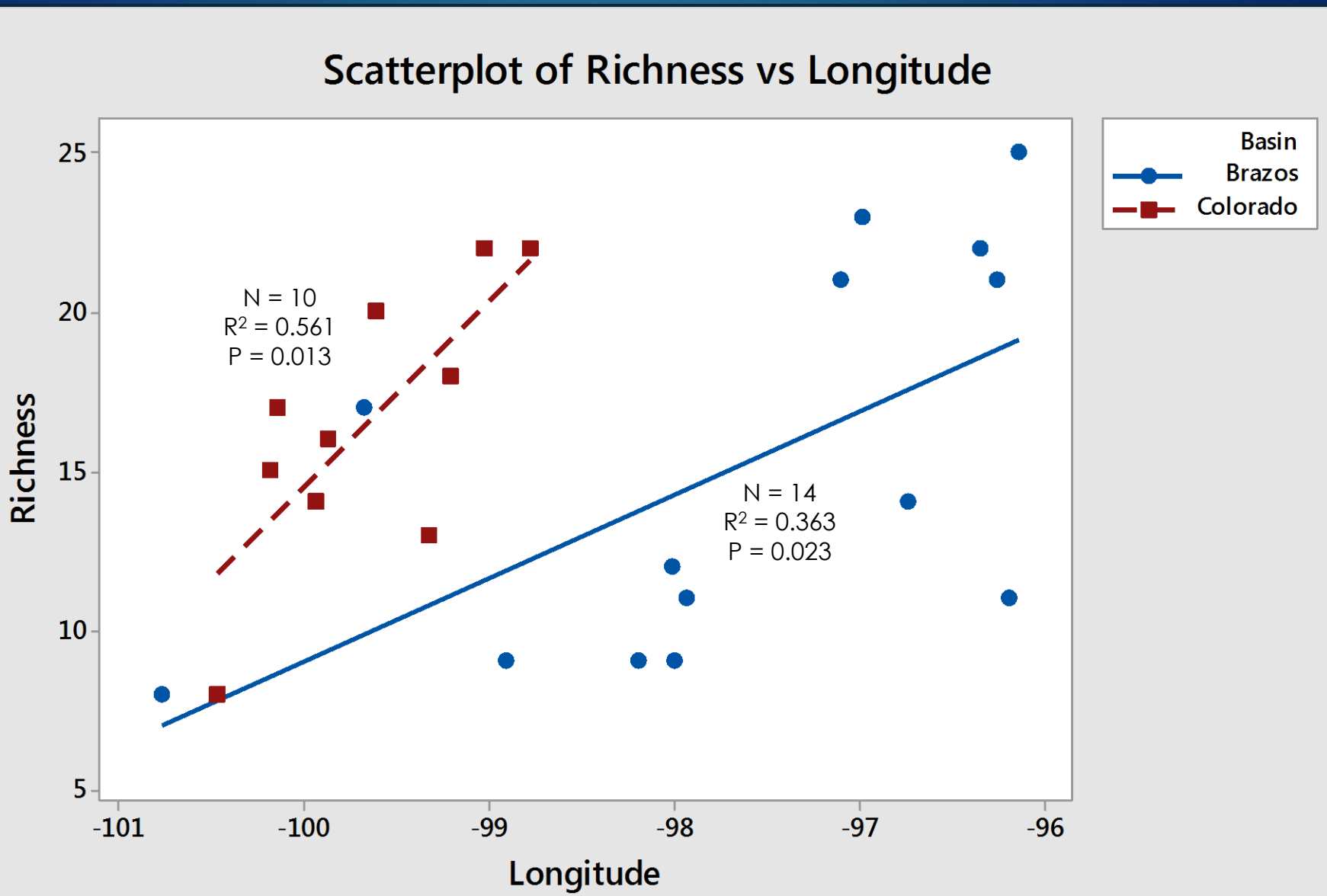


Historical Comparison

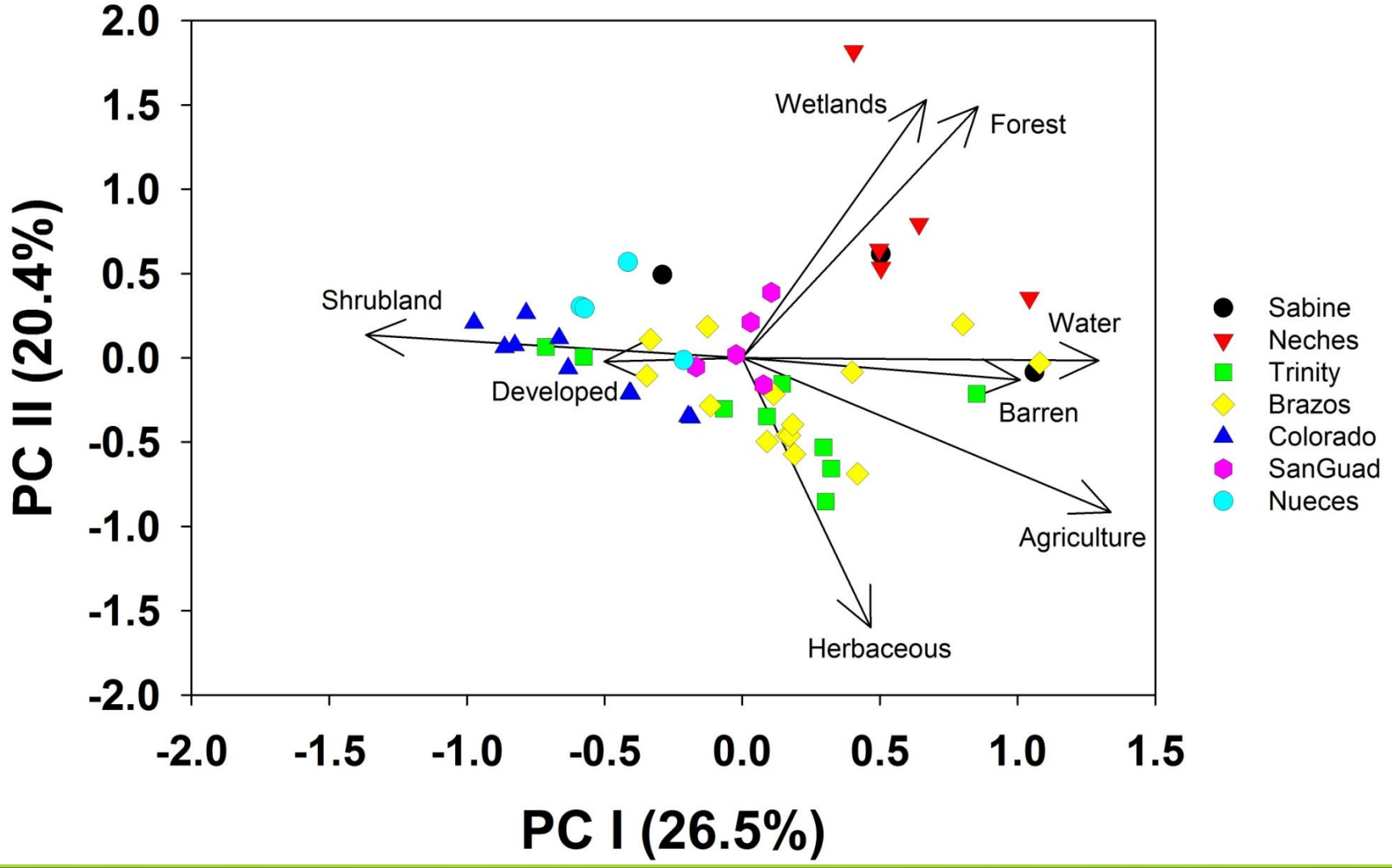




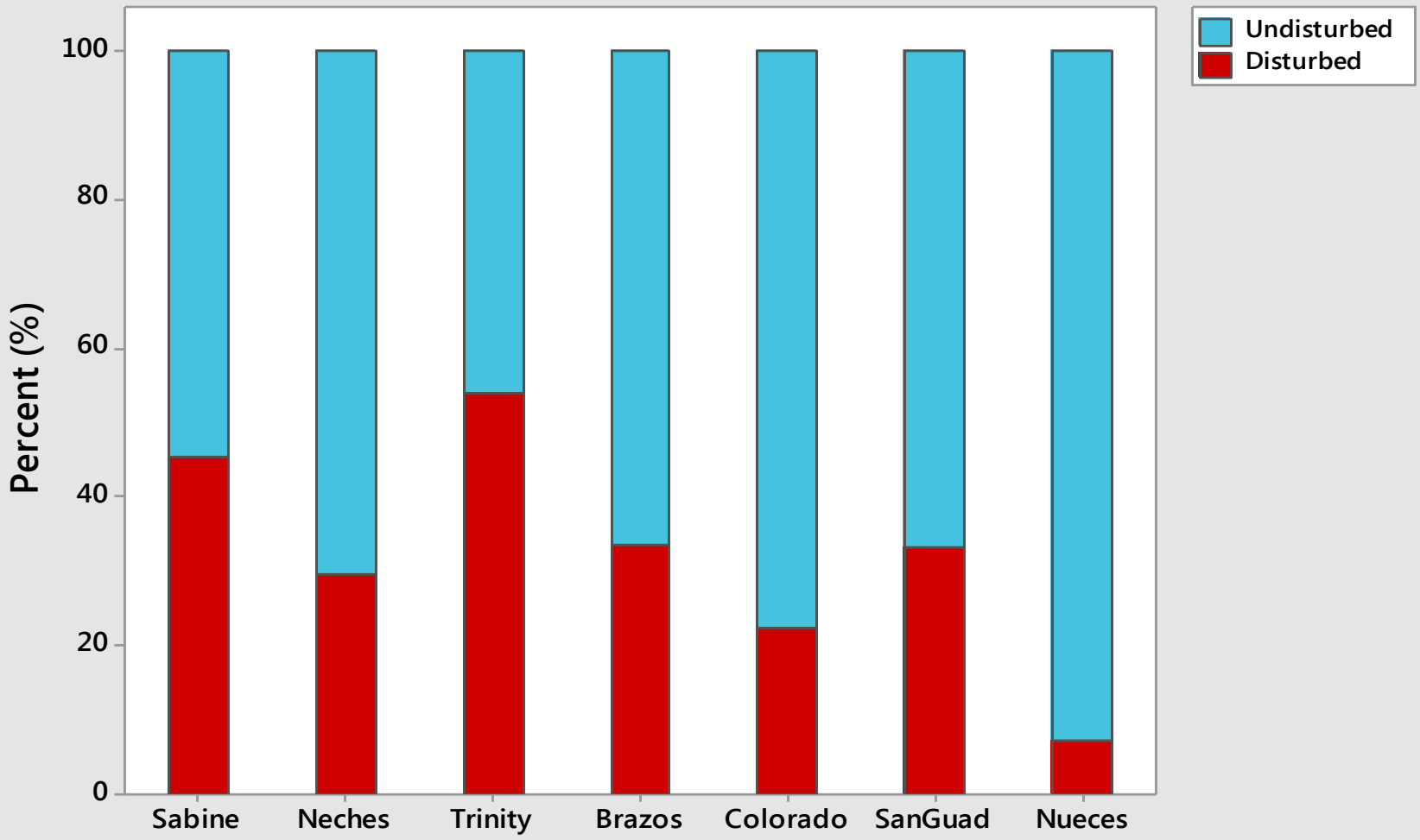

Scatterplot of Richness vs Longitude
Richness
25
20
15
10
5
0
-101
-100
-99
-98
-97
-96
-95
-94
Longitude
N = 51
R2 = 0.044
P = 0.140


Scatterplot of Richness vs Longitude
Basin
Brazos
Colorado
N = 10
R² = 0.561
P = 0.013
N = 14
R² = 0.363
P = 0.023
Richness
25
20
15
10
5
-101
-100
-99
-98
-97
-96
Longitude

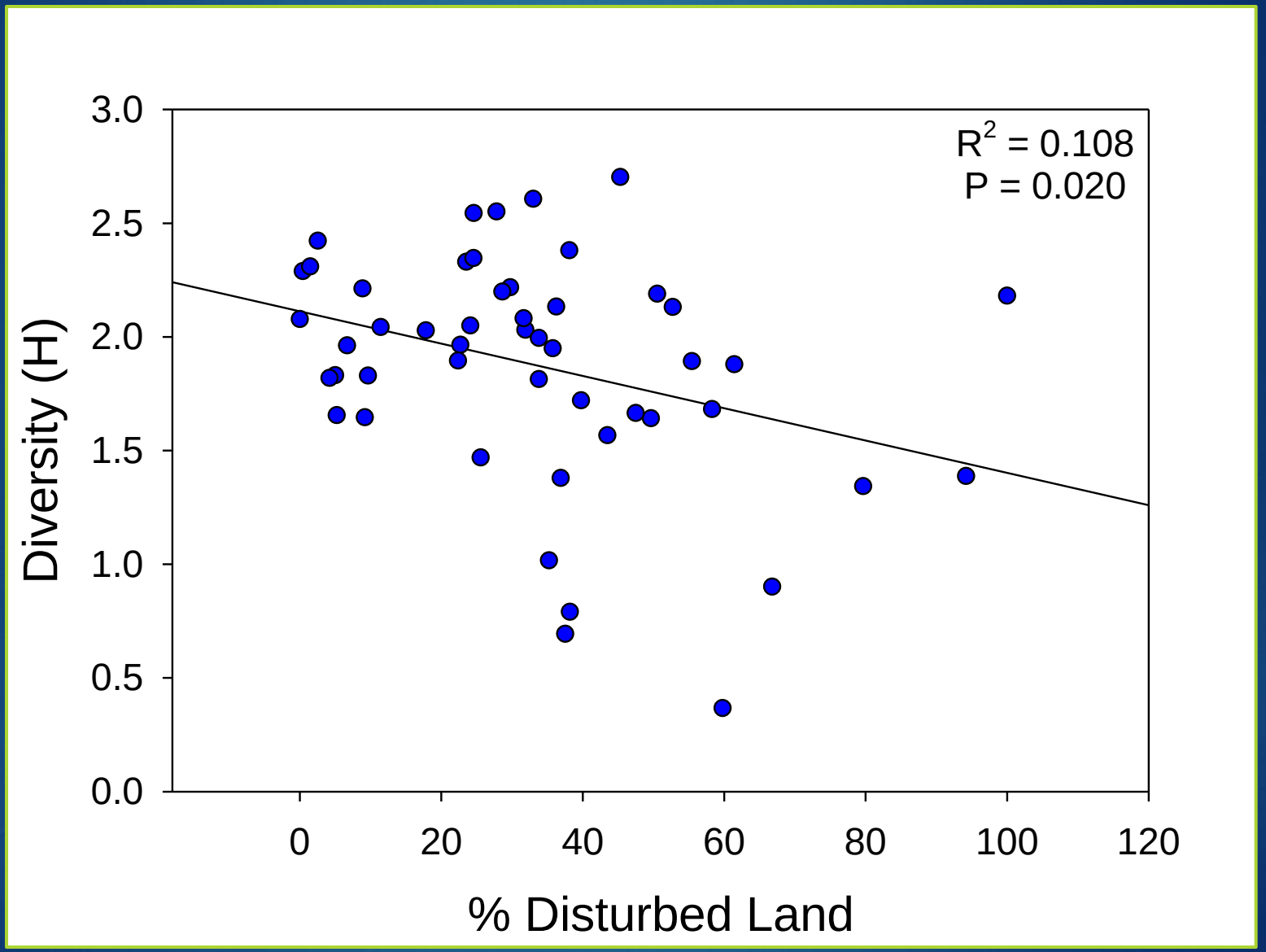
PCA: LULC


2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
PC II (20.4%)
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
PC I (26.5%)
Wetlands
Forest
Shrubland
Water
Developed
Barren
Agriculture
Herbaceous
Sabine
Neches
Trinity
Brazos
Colorado
SanGuad
Nueces

Land Disturbance



Diversity Regression



Summary

- Fish community metrics
  - Richness: 2-25, Diversity: 0.37-2.70
  - Examining diversity across our sample sites indicates a shift towards evenness in statewide diversity
  - Variable findings in regards to historical trends

Summary

- Longitudinal gradients
  - Significant longitudinal gradients observed in Brazos and Colorado drainages
  - Attributable to greater longitudinal span and potentially the distribution of sample sites across a region of steadily shifting topography

Summary

- Land use/land cover
  - Sabine/Neches: forested, wetlands, open water
  - Trinity/Brazos: agriculture, development
  - Colorado/Nueces: arid shrubland

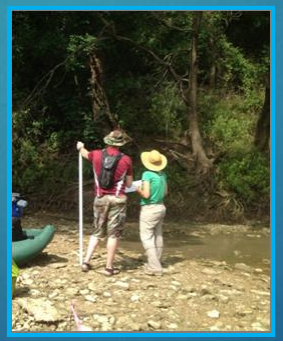
Future Work

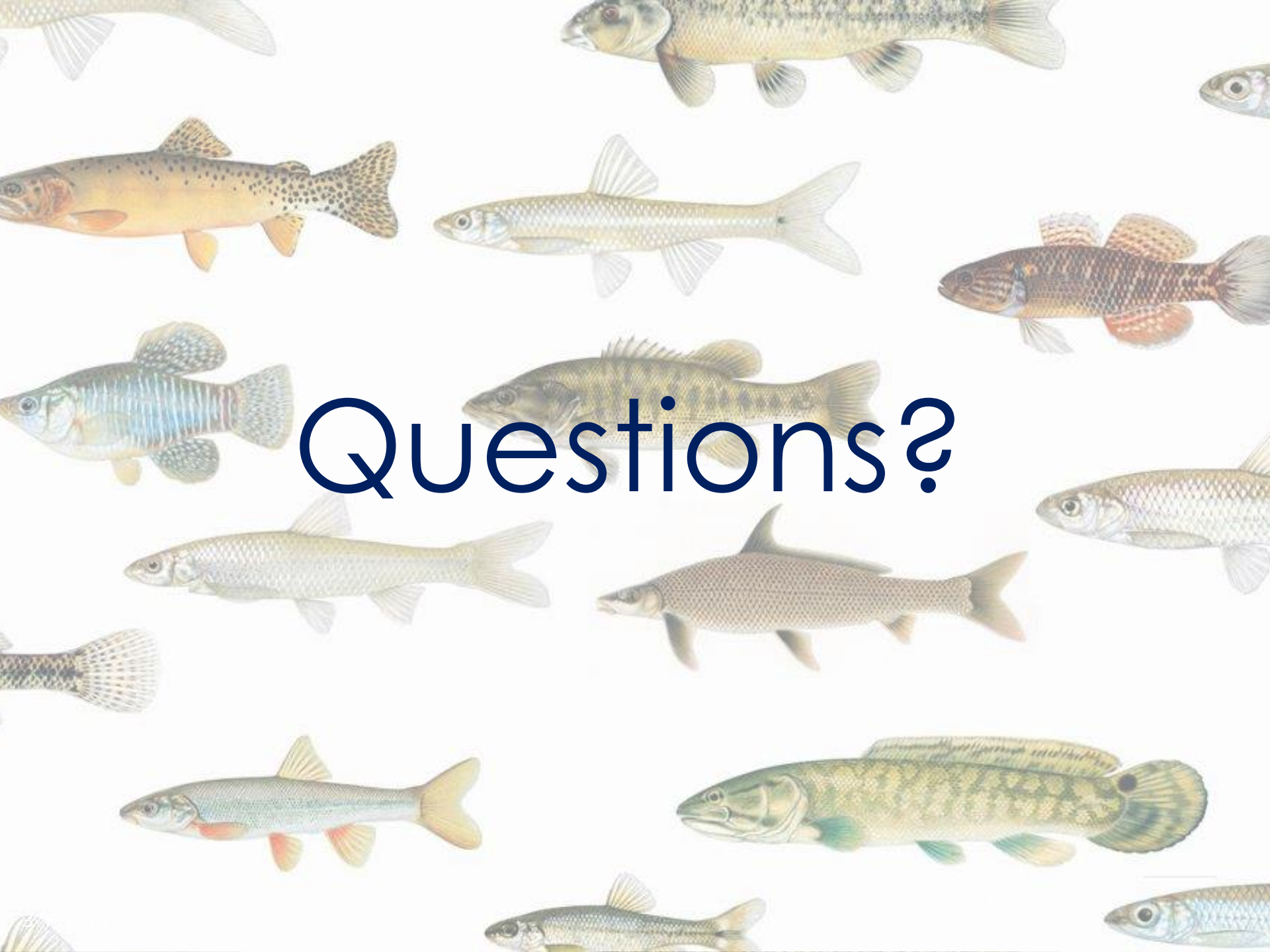
- As observed in other studies[1,2], LULC will be analyzed within a buffer of rivers/streams
- Physical habitat data collected at sites:
  - Mesohabitat
  - Riparian zones
- Additional analysis required to examine:
  - Hydrology
  - Gear bias
  - Historical data

(1) Lammert & Allan 1999 (2) Diana et al. 2006

Acknowledgements

- We would like to especially thank
  - The EPA and TCEQ for funding and project oversight
    - **Robert Cook**
    - **Christine Kolbe**
    - **Michele Blair**
  - EIH staff, students, and interns for site reconnaissance, trip preparation, and many long, hot days collecting data in the field.




Questions?

National Wetland Condition Assessment 2016

- EIH will be conducting these surveys this coming summer – those interested contact:
  - Jenny Oakley – **oakley@uhcl.edu**